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TRANSLATION

Direct experimental study of space goes on. On October 4, 1959, the Soviet Union successfully launched the third space rocket, the purpose of which was to resolve a number of problems in the study of cosmic space and to obtain photographs of the hidden side of the moon and of its edge zones. As exactly calculated, the automatic interplanetary station, which had been specially developed for photographing the hidden side of the moon, passed at a close distance from the moon, went around it and took photographs of the moon disc, invisible from the earth, in accordance with the preset program. With the aid of television apparatus, pictures of the moon were transmitted from the interplanetary station, from distances exceeding several hundred thousands kilometers, when a command was given from the earth.

A new era has been initiated in the history of astronomy; it has been proved that it is possible to study not only the physical parameters of cosmic space and various radiations of heavenly bodies without any obstacles, which are inavoidable when observations are made from the surface of the earth, but also to take close range photographs of the planets. Astronomers no longer will have to wait 15 to 17 years for the occurrence of the time of great opposition of Mars, when the distance between Mars and the earth is reduced to 56 to 60 millions of kilometers. Now, it is possible, in principle, to deliver instruments within a short range of planets in order to take photographs of their surfaces.

Man is no longer chained down to the earth. Due to the efforts of the Soviet people, our generation became contemporary to interplanetary flights.

At the third session of the Supreme Soviet of the U.S.S.R., N. S. Khrushchev made the following statement from the rostrum with regard to this unmatched achievement of the Soviet science: "Why shouldn't we be happy, why shouldn't we be proud of such achievements of the Soviet people as the successful launching of the three space rockets, over a period of one year, 1959, which achievements aroused the admiration of the entire world. The entire Soviet people glorifies men of science and labor who blazed the trail into space".

From the time of Galileo and Newton, who laid the foundation of contemporary natural sciences, the science has won many outstanding victories. Among them are the prediction of existence and discovery of new planets of the solar system Neptune and Pluto. But it is only in our time that first artificial heavenly bodies in the world, satellites of the earth and sun, have been created by the efforts of the Soviet people; that the first flight, in the history of man, was made from one heavenly body to another; that remarkable investigations of cosmic space have been made. Launching of the first Soviet artificial satellites of the earth and cosmic rockets alone has given the science a number of discoveries of world significance; discovery of external radiation belt and the current ring around the earth outside of the ionosphere; sending a living organism into space; obtaining new data on the structure of the magnetic field of the earth; the discovery that the moon does not have an appreciable magnetic field and radiation belts around it; determination of the density of interplanetary gas; obtaining the first photographs of the hidden side of the moon.

The present edition of the Academy of Sciences of the U.S.S.R. is the first publication of results of tentative study of photographs of the hidden side of the moon taken by the automatic interplanetary station. The investigation of these materials proceeds and soon the Academy of Sciences of the U.S.S.R. will publish a scientific paper containing the obtained photographs, the description of formations present on the hidden side of the moon, methods of determination of the nature of these formations and other data.

The scientists of the Soviet Union hope that the publication of materials on taking photographs of the hidden side of the moon will stimulate the further progress of science on the way to conquest of the universe. Signed by the President of Academy of Sciences of the U.S.S.R. Academician A. N. Nesmeyanov.

INTRODUCTION

On the Fourth of October 1959, the Soviet Union successfully launched the third cosmic rocket. The purpose of this launching was to resolve a number of problems in the study of cosmic space. The most important of these problems was obtaining of photographs of the lunar surface. Photographs of that part of the surface, which cannot be observed from the earth due to peculiarities in the movement of the moon, and also that portion of the surface, which is visible at such small angles that it cannot be studied with any validity, were of a particular scientific importance.

A special automatic interplanetary station was developed for the detailed study of cosmic space and for obtaining photographs of the moon.

This station was placed into orbit, rounding the moon, with the aid a multistage rocket. Precisely as calculated, the automatic interplanetary station passed within several thousand kilometers from the moon, changing its direction due to gravitation of the moon. This made it possible to secure a trajectory of flight convenient both for photographing the hidden side of the moon and for transmitting scientific information to the earth.

Launching of the third cosmic rocket and putting the automatic interplanetary station into specified orbit called for the solution of a number of new scientific and engineering problems. A powerful multistage rocket, distinguished by high degree of design, was used for launching the interplanetary station. This rocket was equipped with powerful engines operating on high-calory fuel. Specified characteristics of the rocket flight at the end of initial acceleration was assured by a precision guidance system. Scientific investigations carried out with the aid of automatic interplanetary station made it possible to obtain a considerable amount of materials which at the present time are being processed. Photographs of the hidden side of the moon have been obtained.

INSTRUMENTATION OF THE AUTOMATIC INTERPLANETARY STATION

The automatic interplanetary station is a space flying apparatus equipped with a complex array of electronic, photo-television and scientific apparatus, a special orientation system, programming devices controlling the operations of apparatus carried by the station, the system of automatic control of temperature within the station, and sources of electric power.

The electronic apparatus, carried by the station, was used to measure the parameters of the station orbit, to transmit televised and telemetering information to the earth, and also for receiving commands from the earth, which control the station apparatus.

The photo-television apparatus of the station assured the automatic taking of photographs of the hidden side of the moon, the processing of the film and its preparation for transmission of the image to the earth.

The array of scientific apparatus, installed aboard the automatic interplanetary station, was intended for further investigations of cosmic space and space near the moon, which had been started by the first two Soviet cosmic rockets.

All the operations of the apparatus, carried by the station, were controlled from the ground by radio and also by autonomous programmed devices installed in the station. Such combined systems make possible the most convenient control of scientific experiments and to obtain information from any sectors of the orbit within the radio range of ground observation points.

The specified temperature conditions within the station are maintained by continuously operating automatic system of heat control. By means of this system the heat, given off by instruments, is dissipated through the radiant surface into surrounding cosmic space.

The heat transfer is regulated by shutters, which are installed outside the shell. They open the radiant surface when the temperature within the station rises up to +25°C.

The electric power system has autonomous blocks of chemical sources of energy which provide power for apparatus operating for short periods of time, and also the centralized block of buffer chemical battery. The consumed energy of the buffer battery is compensated by solar sources of electric power. The apparatus, installed in the station, get their power through exerting and stabilizing devices.

The automatic interplanetary station is a thin-walled air-tight shell shaped as a cylinder with spherical ends, inside of which instruments and chemical sources of electric power are arranged. Part of scientific instruments, antennas and sections of the solar battery are mounted outside of the shell. The upper end of the shell has a port with a cover which is automatically opened for taking photographs. The port is located over the objectives of photo cameras and transducers of lunar orientation. The upper and lower ends of the shell have small ports for solar transducers of the orientation system. The controlling motors of this system are mounted at the bottom cover.

The maximum transverse dimension of the station is 1200 millimeters; its length 1,300 millimeters (without the antennas).

The system in which the photo cameras were aimed by turning the entire automatic interplanetary station was recognized as the most efficient system for photographing the moon. The system of orientation turned and maintained the automatic interplanetary station in a desired direction.

The system of orientation was switched on after the station approached closer to the moon, at the moment when it was approximately on the straight line (between the) sun (and the) moon. At this moment, the earth was (not on) the line (between the) sun (and the) moon. When the system of orientation was switched on, the distance to the moon was 60 to 70,000 kilometers according to calculations. A specially chosen trajectory made it possible to realize the above indicated position of the station during orientation. This position made it possible to orient the station with respect to the moon under conditions when the station was illuminated by three bright heavenly bodies, the sun, the moon, and the earth.

The system of orientation consisted of optical and gyroscopic pick ups, logical electronic devices and controlling motors. During its first stage of operation the orientation system first of all stopped the free rotation of the automatic interplanetary station about its center of gravity, which was started at the time the last stage of the carrier rocket was separated.

After the rotation had been stopped, the bottom end of the station was aimed at the sun by means of solar pick ups. In this position of the station, the optical axes of photo cameras were directed towards the moon.

After that, the solar orientation pick ups were turned off by an appropriate optical device, in the field of vision of which the sun and the earth could no longer appear again, and the photo cameras of the station were oriented precisely with respect to the moon. A signal "the moon is present", given by an optical device, initiated the automatic photography. The system of orientation assured that the automatic interplanetary station was continuously aimed at the moon during the entire time of taking photographs.

After all of the frames were exposed, the orientation system was switched off. At the moment it was switched off, the orientation system imparted the ordered rotation with a definite angular velocity to the automatic interplanetary station. The velocity was chosen such that, on the one hand, the thermal conditions would be improved and, on the other hand, the operation of scientific apparatus would not be affected by the rotation.

FLIGHT OF THE INTERPLANETARY STATION

Problems associated with the orientation and radio communication with the automatic interplanetary station set up special requirements as to the trajectory of its flight.

As it has been stated previously, the initial basis for normal operation of the orientation system is the condition that the moon, the station and the sun would be located approximately on the same straight line at the time this system begins to function. Moreover, at this time the station should be within the range of distances mentioned in the preceding section.

Due to the great volume of information broadcast from the interplanetary station to the earth, the trajectory of the flight had to be such as to permit the ground receiving stations, disposed over the territory of the U.S.S.R., to obtain the maximum amount of information during the very first revolution and, particularly, at short distances from the surface of the earth.

It was also quite desirable, for purposes of scientific investigations, to obtain a trajectory which would assure the flight of the interplanetary station through space over a sufficiently long period of time.

The investigations have shown that these requirements can be satisfied to the utmost, if the gravitational force of the moon is utilized in constructing the orbit of the station. In order to secure an orbit of the station of required characteristics, it is necessary that the gravitational force of the moon would be quite definite as to magnitude as well as to direction. The moon can appreciably affect the flight of the station only in that case when its gravitational force is sufficiently high. To achieve this, the station must pass within close range of the moon. In order to change the directional characteristics of the orbit, the station must pass on a quite definite side of the moon. To be more exact, the direction of the effect of lunar gravitation is determined by the inclination of the plane of the station orbit with respect to the plane of lunar orbit in the seleno-centric movement.

In order to fly around the moon and return to the earth, the velocity of the initial acceleration must be somewhat less than the so-called secondary cosmic or parabolic velocity, which at the surface of the earth is equal to 11.2 kilometers/sec. Furthermore, the flight around the moon and back to the earth may have different types of trajectories.

If the trajectory of the flight passes at distances of several tens of thousands of kilometers from the moon, the influence of the moon would be relatively small and the motion with respect to the earth would occur along the trajectory approximating an ellipses with its focal point in the center of the earth. However, the distant flight around the moon, at the distance of several tens of thousands of kilometers from it, have a number of important short comings. A direct investigation of cosmic space in the immediate vicinity of the moon is impossible when the flight is at great distances from the moon. When a rocket is launched in the northern hemisphere of the earth, the return flight occurs on the side of the southern hemisphere, which hinders observations and reception of scientific information by the stations located in the northern hemisphere. During the return flight, the motion near the earth occurs beyond the visibility of the northern hemisphere and, therefore, near the earth the radio communication becomes impossible. When returning to the earth, the rocket enters the dense layers of the atmosphere and burns out, that is the flight ends after the first revolution.

The utilization of directional effect of lunar gravitation, when the rocket passes close to the moon, in constructing the orbit of the automatic interplanetary station made it possible to secure an orbit devoid of shortcomings inherent in trajectories of a distant flight around the moon. The trajectory of the flight of the automatic interplanetary station passed at the distance of 7,900 kilometers from the center of the moon and was chosen so that at the moment of maximum approach the station would be south of the moon. Due to gravitational forces of the moon, the trajectory of the automatic station was deflected to the north, which is in accordance with calculations. This deflection was so appreciable that the return flight to the earth occurred on the side of the northern hemisphere. Furthermore, after the station became close to the moon, the maximum altitude of the station above the horizon with respect to observation points located in the northern hemisphere, increased more each day. Accordingly, the time intervals, during which the direct communication with the automatic station was possible, also increased. When the automatic station approached the earth, it could be observed in the northern hemisphere as a star that does not set.

When returning to the earth, the station did not enter the atmosphere during the first revolution and did not burn out but passed at the distance of 47,500 kilometers from the center of the earth forming a long elongated orbit, the shape of which approximates that of ellipse. The greatest distance from the station to the earth was 480,000 kilometers.

The flight of the interplanetary station near the earth occurred at such great distances from its surface that the deceleration effect, due to atmospheric resistance, was absent. Therefore, if the motion occurred only due to the action of gravitational force of the earth, the automatic station would become a satellite of the earth with infinitely long life.

However, in reality, the life of the station is limited. Due to perturbing effect of solar gravitation, the closest distance of the orbit from the earth, the height of the orbit perigee, gradually decreases. Therefore, having made several revolutions, during one of its return flight to the earth the station will enter the dense layers of the atmosphere and that will end its existence.

A decrease in the altitude of the perigee after one revolution depends upon the size of the orbit and, particularly, upon the altitude of the apogee, that is upon the greatest distance of the orbit from the earth. It abruptly increases as the altitude of the apogee is increasing. Therefore, when making a choice for the trajectory of interplanetary station it is necessary to strive to have the altitude of the apogee as small as possible and not exceeding the distance from the earth to the moon by much. It is also necessary that the altitude of the perigee during the first revolution would be as high as possible. Upon the degree of satisfying both of these given requirements depends the total number of revolutions of the automatic station around the earth and its life.

The influence of the moon is not limited to that effect which she has during the period of the first approach. Turbulences of the orbit of the station caused by gravitation of the moon do not have the regularity of turbulences produced by gravitation of the sun and to a greater measure depend upon the circling period of the station around the earth. The influence of the ~~earth~~ Moon may turn out to be important, if during one of the revolutions the trajectory of the automatic station again will pass sufficiently close to the moon. In this case, the rapprochement of the station and the moon would occur approximately at the same point of the lunar orbit as during the first time. The nature of movement of the station, however, may be essentially different. If the interplanetary station passes near the moon on its south side, that is the rapprochement is of the same type as the first one, the number of revolutions and also the life of the station will be drastically increased with retaining the principal property of its trajectory: approach to the earth from the side of northern hemisphere. If it would pass on the north side, the altitude of the perigee of the orbit would be decreased and in the case of sufficiently high perturbance an impact with the earth may occur during the closest return to it.

During those turns of the orbit, when the rapproahment with the moon is not sufficiently close, the moon, nevertheless, has a certain influence on the movement of the station. Although the gravitational force of the moon in this case is very small, it noticeably affects the movement of the automatic station, acting upon a considerable number of turns of trajectory, causing a decrease in the altitude of perigee and the orbiting life of the station.

The picture of the movement of automatic interplanetary station exposed to simultaneously acting gravitational forces of the earth, moon, and the sun, is very complex. The nature of passing near the moon during the first rapprochement determines the further movement of the interplanetary station.

Since the movement of the interplanetary station is not corrected during the flight and its entire flight (in the final analyses) is determined tr

by the parameters of the motion at the end of the initial acceleration (basically by the magnitude and direction of velocity), it is clear that it is to secure the above described trajectory of the interplanetary station ~~is~~ possible only by having an extremely precise guidance system of the rocket vehicle during its initial acceleration.

Let us assume that the plane is drawn through the center of the moon perpendicular to the line between the earth and the moon. This plane we shall call the picture plane. Peculiarities of the trajectory with respect to the moon may be characterized by the position of points of intersection of the trajectory with the picture plane.

Calculations indicate that when the point of intersection of the trajectory and picture plane deviates from the nominal position by 1,000 kilometers, the minimum distance of the station from the earth, at the end of the first revolution, may change by five to 10,000 kilometers and the time of return flight to the earth by 10 to 14 hours.

On the whole, in ~~to~~ satisfying all of the requirements set up for the trajectory of the flight around the moon, it is possible to have greater deviations from the calculated position of the point of intersection of the trajectory with the above indicated plane than in the case of hitting the moon, which was done by the second Soviet cosmic rocket; nevertheless the requirements of precise guidance during the initial acceleration for the former case, remain just as rigid as in the case of hitting the moon. This is basically due to the fact that in the case of elliptical trajectories of the flight around the moon errors in the magnitude of the velocity at the end of the initial acceleration could cause deviations of the point of intersection of the trajectory with the picture plane, which deviations are three to four times as great as in the case of hyperbolic trajectories which are feasible for hitting the moon.

When the orbit of the station passes close to the moon, its perturbative action appreciably magnifies the influence [redacted] of deviation of parameters of motion at the end of initial acceleration from their calculated values, upon the nature of motion of the station during its return flight to the earth after rounding the moon. Therefore, even small errors in determination of these parameters lead to important errors in calculating the characteristics of motion of the interplanetary station during its return flight to the earth.

At the same time, in order to secure a reliable radio communication between the interplanetary station and ground observation stations it is necessary, to know with sufficient accuracy the alteration of characteristics of motion of the (interplanetary) station occurring with time. This is needed in order to ~~(that)~~ measurement taking ~~points~~ stations ~~could~~ calculate with required precision the ~~radar~~ targets for the ~~plots~~ and also for determination of time for switching on the transmitting devices aboard the station. This circumstance requires that the trajectory of the interplanetary station be measured systematically, and that the data be processed and characteristics of the motion of the station be adjusted prior to its approach to the moon as well as after it flies around the moon. The influence of the sun and the moon on the evolution of the orbit of interplanetary station, during its further flight, also require constant measurement and correction of characteristics of motion of the station.

The above enumerated circumstances impose important requirements on the operation of the automatic ground system intended for measuring the parameters of the trajectory of interplanetary station, predicting its motion by calculations, calculation of radar plots (targets) ~~by~~ for observation and measurement taking stations, calculation of the time for switching on the transmitters aboard the interplanetary station during its entire flight around the earth.

The ground system comprises radio stations that measure the range, angular parameters and radial velocity of an object, stations that receive telemetered information, automatic communication lines between the stations which take measurements and coordinating-computation center, which in turn is connected with ground stations which give commands for switching on the transmitters aboard the automatic interplanetary station.

The command radio line made it possible to switch on the means of radio communication at definite time intervals corresponding to favorable conditions for radio communication between the interplanetary station-radios and ground stations located on the territory of the Soviet Union. The duration and the time of switching on radio communication were determined by the operating conditions of the apparatus carried aboard the station, by the need for carrying out trajectory measurements for correcting the characteristics and prediction of motion of the interplanetary station and also by the conditions of normal power supply of devices carried aboard the station.

The data on the position of the interplanetary station at the time of taking photographs, which have been established as a result of processing trajectory measurements, and which are needed for turning in the discovered objects on the far side of the moon to the selenographic coordinate grid, are shown in the table. (See p. 32)

Tentative processing of trajectory measurements at the first revolution of the orbit made it possible to establish that the automatic station will be in orbit ~~by~~ till the end of March, 1960, and will make 11 revolutions around the earth.

PHOTOGRAPHING AND TRANSMISSION OF IMAGES

In the course of developing the system of instruments for taking photographs and transmitting images of the far side of the moon from the automatic interplanetary station, the photo-television system has been developed which has made it possible to obtain half-tone photographs of sufficient clarity and to transmit them through distances measured in hundreds of thousands of kilometers.

The photo-television apparatus installed in the interplanetary station had the following basic components: the photo camera with two objectives; a small device for automatic development and fixing of the film; a small electron-ray tube; a photo-electric multiplier of high stability; an electronic system with amplifiers and scanning devices; a system of automation and programming.

The design of photo-television apparatus assured its efficiency under complex conditions of space flight; it assured the safety of photo materials under conditions of harmful action of cosmic radiation, the normal operation of the unit for processing photo materials and also operation of other instrument systems under conditions of weightlessness.

For super long range transmission of images by a radio transmitter of quite low power, the ~~velocity~~ speed of transmission of images was used which was 10,000 times as slow as the speed of transmission ~~velocity~~ of standard television broadcasting centers.

When photographing the far side of the moon for the first time, it was desirable to photograph as large a portion of its unexplored surface as possible. This necessitated taking photographs of a fully illuminated disc, a contrast of which is always considerably lower than in oblique illumination which creates shadows of the relief and details. In order to have better transmission of a low-contrast photograph, an automatic control of the contrast of transmitted image was provided for in the photo-television apparatus.

7.874in 19.685in

The photo-camera was equipped with two objectives with focal distances of 200 and 500 millimeters with relative apertures of 1:5.6 and 1:9.5.

The objective with the focal distance of 200 millimeters produced an image of the total lunar disc ~~completely inscribed in a frame~~. The objective with focal distance of 500 mm produced a large-scale image of a portion of the lunar disc only.

Photographs were taken on a special 35 mm film that could be processed at high temperature.

Photographs were taken with exposure times altered automatically, in order to obtain negatives of the most appropriate density. Photographing lasted for about 40 minutes. During this time many photographs of the far side of the moon were taken.

The entire process of photographing and processing of the film was made automatically in accordance with preset program.

In order to prevent the film from becoming cloudy due to the action of cosmic radiation, a special protection was provided for which was chosen on the basis of investigations carried out with the aid of Soviet artificial satellites and cosmic rockets.

After the film was exposed, it was transmitted into a small device for automatic processing, where it was developed, dried and fixed.

After that, the film was placed in a special cassette and prepared for transmission.

Photographs of the moon were transmitted when the command was given from the earth. These commands switched on the power of television apparatus of the station, the running of the film and also connected the television apparatus to the transmitters of the station.

Coordination and control of operations of all components including electronic systems, optical, mechanical and photo-chemical instruments, were accomplished by the system of automation and programming.

In order to convert the image on the negative into electrical signals, the transparency was recorded similar to a method used by television centers for transmitting movies: a small electron-ray tube with high resolving capacity created a bright luminous spot, which by means of an optical system was projected onto the film. The light, which passed through the film, entered the photoelectric multiplier which converted the light signal into an electrical signal.

The light spot on the screen of the electron-ray tube moved coincidental with electric control signals produced by a special scanning system. The dimensional illuminous spot moved uniformly across the film from one edge to another and on reaching the latter quickly returned to its initial position and again resumed its uniform movement across the film. This assured "line" scanning of the image. The film itself was slowly drawn past the electron-ray tube, which assured "frame" scanning.

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The ~~power~~ intensity of light, which passes from the electron-ray tube through the film into the photoelectric multiplier, is determined by the density of the negative at the point at which the spot of light is present. When the spot moves over the negative, the amperage in the photoelectric multiplier is altered in accordance with the regularity of changes in the density of the image along the line; thus, an electrical "signal of image", which reproduces the regularity of changes in the density of negative along the scanning line, is created at the output of the photoelectric multiplier.

The image signals were amplified and formed by specially developed narrow-band stabilized amplifier.

In as much as the average density of the negative and the contrast of the image were not known in advance, the amplifier was provided with a device for automatic adjustment which assured that the influence of changes in the average density of the negative on the output signal was compensated for. The automatic adjustment of brightness of the electron-ray tube, compensating for changes in contrast, was also provided.

Test symbols had been previously photographed on the film; some of them were developed on the ground and some developed aboard the station when processing the frames taken of the far side of the moon. These symbols were transmitted to the earth and provided an opportunity for checking the process of photography, processing and transmission of images.

Two methods of transmission of the images were provided for: ~~one~~ a slower transmission at long ranges and a more rapid at close distances, when approaching the earth.

The number of lines into which the image was resolved could change depending upon the chosen method of transmission. The maximum number of lines reached 1,000 per one frame.

Transmitting and receiving scanning devices were synchronized by ~~the~~ a method which assured a high level of stability of noise~~proof~~ and ~~service~~ reliability of instruments.

The radio communication which was used assured a two-way transmission of radio signals. Command signals, which controlled the operations of instruments aboard the station, were transmitted in the direction "earth-automatic interplanetary station". Television signals, signals with the data obtained by scientific instruments, and signals for measuring the parameters of motion of the station itself were transmitted in the direction "automatic interplanetary station-earth". Ground equipment comprised powerful radio transmitters, highly sensitive receivers, recording apparatus and also receiving and transmitting antenna systems. Radio equipment aboard the automatic interplanetary station comprised transmitting, receiving and antennae systems and also electronic command and programming device ~~electronic timers~~.

Photographs of the moon were transmitted from the automatic interplanetary station over a radio communication line which at the same time was used for measuring the parameters of motion of the station itself.

Transmission of photographs of the moon and other functions of the radio communication with the interplanetary station were realized by means of continuous emission ~~(oscillation)~~ of radio waves (in contrast to pulse oscillation). This combination incorporation of functions into one radio communication line with continuous emission ~~oscillation~~ has been done for the first time and made it possible to assure a reliable radio communication within maximum ranges and with the least consumption of energy aboard the station.

All the apparatus of the radio communication line aboard the station as well as at ground stations were doubled in order to improve the reliability of communication. If one of the electronic devices aboard the station were to break down or if its servicability were exhausted, it could be replaced by a standby device by transmitting an appropriate command from the ground control station.

The total volume of scientific information transmitted over the radio communication line, including the photographs of the moon, many times exceeded the volume of information transmitted by the first and second Soviet cosmic rockets. This necessitated the use of the most effective methods for receiving photographs and for transmitting signals over the radio communication line. These methods assured the minimum consumption of energy of power sources aboard the station.

Semiconductors, ferrites, and other modern components and materials were used in the electronic apparatus carried by the station. Particular care was exercised to minimize the volume and weight of devices which made it possible to increase the weight and volumes intended for sources of electrical power. Due to considerations of saving the electric power, the power of radio transmitters carried by the station were limited to several watts.

An idea of difficulties which are encountered in trying to assure a reliable radio communication with the interplanetary atutomatic station may be gained if ~~it~~ is calculated ~~what~~ the fraction of ~~power oscillated~~ energy radiated (emitted) by the radio transmitter of the station ~~is~~ and received by the ground receiving system.

In order to maintain ~~the~~ communication with the station, uninterrupted by its rotation, the antennas on the station had to ~~oscillate~~ radiate emit the signals uniformly in all directions so that the ~~power of oscillation~~ radiation-energy per unit of surface would be approximately equal for all points on an imaginary sphere ~~in the~~ center ~~of which~~ at the station ~~was located~~.

The ground receiving antenna receives a fraction of radiating ~~power which is~~ energy determined by the ratio of the effective area of the receiving antenna to the surface of the sphere ~~the~~ with radius ~~of which is~~ equal to the distance from the interplanetary station to the receiving point. In order to increase the effective area of the antenna for receiving signals from the interplanetary station, large receiving antennas were used.

However, even in this case ~~to set the~~ at maximum distance of the interplanetary station from the earth, the received portion of the radiat~~ing~~ed energy ~~power of the transmitter~~ is 100 million times as small as the average ~~power~~ received by a standard television receiver. Such weak signals may be received only by very sensitive receivers ~~which have~~ with a ~~small~~ low noise level ~~of their own noises.~~

10^8

The ~~net~~ noises ~~at the~~ output of the ground receiving unit ~~were~~ was reduced to ~~the~~ a minimum by taking a number of special measures.

According to ~~postulates of the~~ theory ~~of information~~ and the theory of ~~the noiseproof~~ feature (noise suppression), the reception of very weak signals ~~on~~ against the background ~~of noises~~ may be assured by reducing the rate of transmission of information. The level to which the rate of information transmission can be reduced depends upon the method chosen for transmission and reception of radio signals.

In the radio communication line such methods of processing and transmitting signals were used aboard the station and at ground receiving points which reduced level of noises to a maximum degree but retained the permissible rate of transmission.

An economical ~~utilization~~ use of power sources aboard the station, the availability of a radio communication line with continuous function and combined functions ~~are incorporating several functions and with the continuous oscillation, the use of~~ special receiving antennas on the ground, highly sensitive receiving systems, the ~~utilization~~ use of special methods of processing and transmitting signals, ~~all this~~ made it possible to assure reliable radio communication with the automatic interplanetary station, uninterrupted operation of the command radio line and the systematic transmission of photographs of the moon and telemetering information.

The signals of the photographs of the moon were received on the ground by special systems for recording televised images on film, by tape recorders with highly stable velocity of the magnetic tape, by skiatrons (electron-ray tubes with screen that retains images for a long period of time) and by open recording apparatus recording images on electrochemical paper. Information obtained by all types of recording was used in studies of the far side of the moon.

With the aid of radio-television apparatus, installed aboard the automatic interplanetary station, photograhs were transmitted at various distances all the way to 470,000 kilometers. This experimentally confirms the possibility of transmitting half-tone pictures of great clarity through space to super-long distances without appreciable specific distortions occurring during the process of propagation of radio waves.

THE FAR SIDE OF THE MOON

The period of the rotation of the moon about its axes corresponds to the period of its rotation around the earth. For this reason, one and the same side of the moon is always facing the earth. During the very distant past, millions of years ago, the moon rotated about its axes with greater speed than now, making one revolution in several hours.

The forces of tidal friction, produced by the gravitational forces of the sun and the earth, retardes ~~slow~~ the moon, having prolonged the period of its rotation about its axes to 27.32 days.

In the course of 350 years of telescopic observations, maps were compiled of the side of the moon which faces the earth. Beginning with the very first drawing of the lunar surface, these maps were improved all the time and enriched as the means and methods of observation were becoming more advanced. At the present time, maps are available upon which tens of thousands of ring mountains, craters, are plotted; numerous mountain ranges; dark regions of lunar soil, which are called seas; cracks of fantastic shapes and numerous other details of lunar surface.

The presence of the so-called librations of the moon, that is periodic oscillations of the moon around ~~near~~ its center, which are visible for terrestrial observer, made it possible to investigate and map 59 per cent of its surface. Some lunar formations are located at the very edge of the visible disc. Some of these formations are visible only when the librations of the moon are favorable. All of these edge zones were mapped with some distortions caused by perspective.

The time chosen for photography, allowed the automatic interplanetary station to photograph the greater part of the hidden surface of the moon and a small area with already known formations. When the photographs were taken, the disc of the moon, almost completely illuminated by the sun, was facing the station. Under these conditions of illumination of the lunar surface, its formations do not cast shadows and certain details become undistinguishable. Photographs of that area of the moon, which is visible from the earth, made it possible to connect tie in the objects located on the hidden side of the moon with already known objects and to determine their selenographic coordinates. In the photograph the boundary between the visible and hidden parts of the moon is indicated with a broken line.

Among objects, the photographs of which were taken from the interplanetary station and which are visible from the earth, there are Humboldt sea, Sea of Crises, the Edge Sea, Smyth Sea, part of the South Sea, etc.

These seas, located at the very edge of the moon which is visible from the earth, appear to us as narrow and elongated due to distortion of the perspective. Their true shapes had not been previously determined. In photographs, taken from the interplanetary station, these seas are located far from the visible edge of the moon and their shapes are slightly distorted by the perspective.

On the basis of tentative investigation of available photographs, it is possible to state that mountainous regions predominate in the hidden part of the lunar surface, whereas the seas, similar to seas of the visible part, are very few. Greater seas, located in the southern and near equatorial regions stand out sharply.

Among the seas located near the edge of the visible region, the photographs show distinctly almost without any distortion Humboldt Sea, the Edge Sea, Smyth Sea and South Sea. It turned out that a considerable part of the Southern Sea is located on the far side of the moon and that its boundaries have irregular, wavy shapes.

As compared with the South Sea, Smyth Sea has a more circular shape. On the southern side a mountainous region protrudes into it. A considerable section of Smyth Sea extends over the far side of the moon. The Edge Sea has an elongated shape and an indentation in the direction opposite to that of the Sea of Crises. Just as Smyth Sea, it extends to the hidden side of the moon. Humboldt Sea has a peculiar pear-like shape.

The entire region, adjacent to the western edge of the far side of the moon, has a reflective power intermediate between the mountainous regions and the seas. As to the reflecting power, it is similar to the region of the moon located between the crater of Tycho, Crater of Batavius and Sea of Nectar.

To the southeast by south from Humboldt Sea, along the boundary of the above mentioned region, there is a mountain chain the total length of which exceeds 2,000 kilometers. It crosses the equator and extends into the southern hemisphere. Beyond the mountain chain apparently stretches the continental shield, with higher reflecting power.

The Crater Sea, about 300 kilometers in diameter, is located in the region between +20 and +30 degrees latitude and +140 and +160 degrees longitude. The southern part of this sea terminates with a bay. A large crater, the diameter of which exceeds 100 kilometers, which has a dark bottom and bright central elevation surrounded by a light wide ridge, is located in the southern hemisphere in the region the coordinates of which are -30 degrees latitude and +130 degrees longitude.

To the east of previously mentioned mountain chain, in the vicinity of +30 degrees northern latitude, there is a group of four craters of average dimensions, the largest of which has a diameter of about 70 kilometers. There is an isolated crater, of a round shape, through the southwest of this group in the region of +10 degrees latitude and +110 degrees longitude. Two regions with drastically reduced reflecting power are located in the southern hemisphere near the western edge.

Moreover, the photographs show separate regions with slightly increased and decreased reflecting powers and numerous fine details. It will be possible to determine the major of these details, their shapes and dimensions by serious study of all photographs.

The fact that for the first time it was possible to televise images of the far side of the lunar surface from the interplanetary station opens up wide horizons for the study of planets of our solar system.

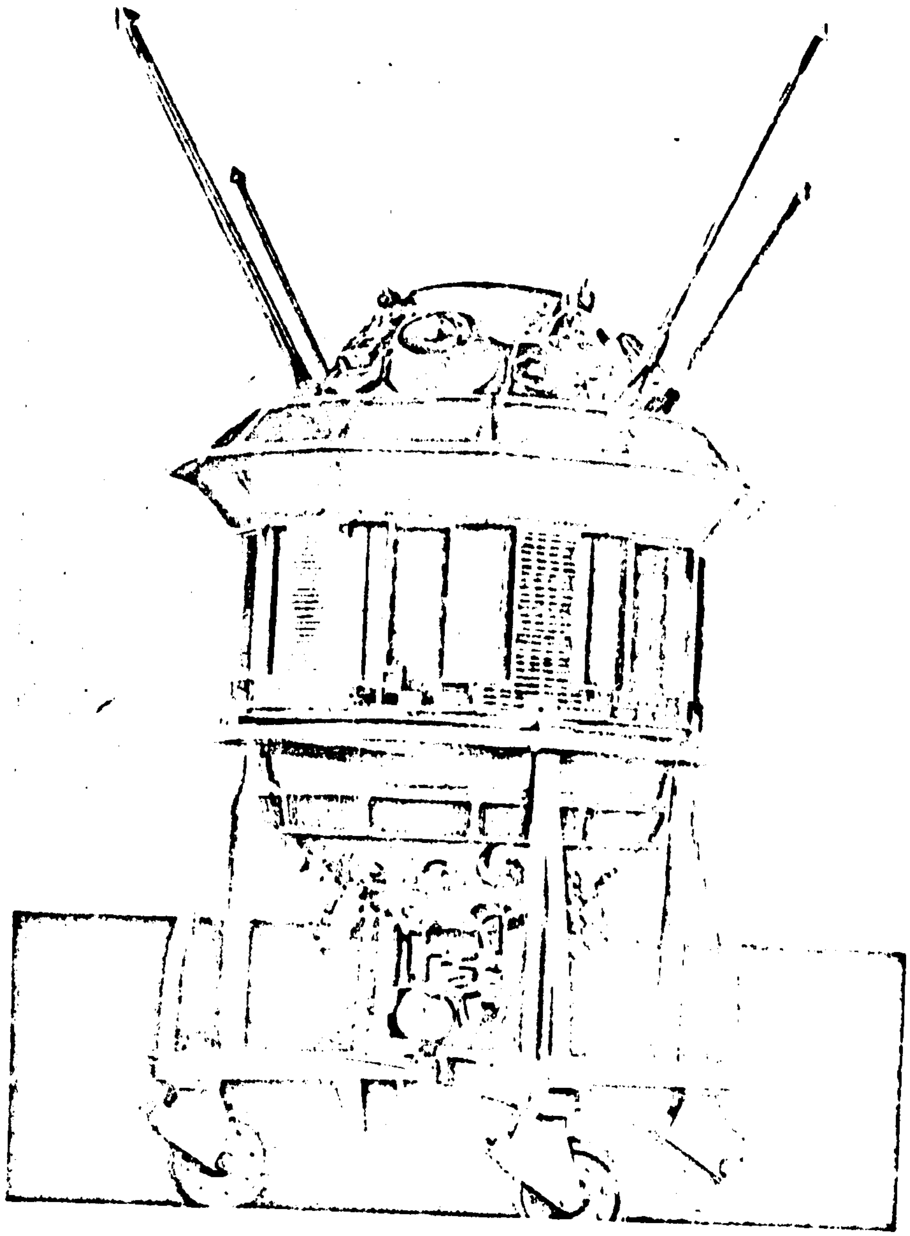

Рис. 1. АВТОМАТИЧЕСКАЯ МЕЖПЛАНЕТНАЯ СТАНЦИЯ НА МОНТАЖНОЙ ТЕЛЕЖКЕ (фотография)

FIGURE 1. AUTOMATIC INTERPLANETARY STATION ON THE ASSEMBLY CARRIAGE (Photograph)

FIGURE 2. GENERAL VIEW OF THE AUTOMATIC INTERPLANETARY STATION (Schematic Drawing)

1 - port for photo cameras; 2 - motor of the orientation system; 3 - solar transducer; 4 - sections of solar battery; 5 - shutters of the heat regulating system; 6 - heat screens; 7 - antennas; 8 - scientific instruments.

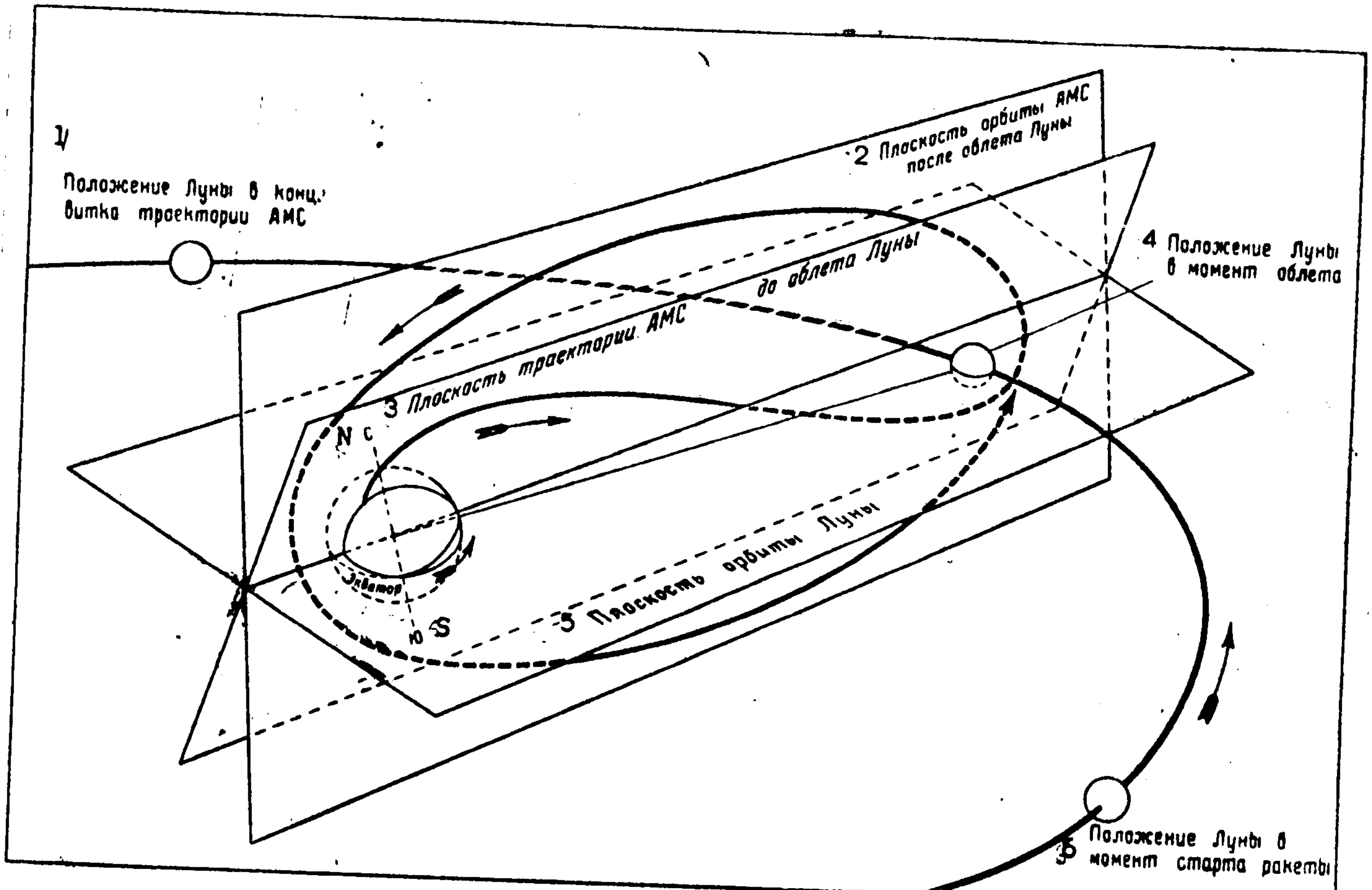

Рис. 3. СХЕМА ТРАЕКТОРИИ ПОЛЕТА АВТОМАТИЧЕСКОЙ МЕЖПЛАНЕТНОЙ СТАНЦИИ

FIGURE 3. A SCHEMATIC DRAWING OF THE FLIGHT TRAJECTORY OF THE AUTOMATIC INTERPLANETARY STATION AIS.

1 - Position of the moon at the completion of revolution with trajectory ~~AMC~~ AIS
2 - Plane of orbit ~~AMC~~ after rounding the moon AIS
3 - Plane of trajectory ~~AMC~~ prior to rounding the moon
4 - Position of the moon at the time of rounding
5 - The plane of moon orbit
6 - Position of the moon at launching time.

Рис. 4. ТРАЕКТОРИЯ ПОЛЕТА АВТОМАТИЧЕСКОЙ МЕЖПЛАНЕТНОЙ СТАНЦИИ:
а — вид со стороны точки весеннего равноденствия; б — проекция на плоскость земного экватора

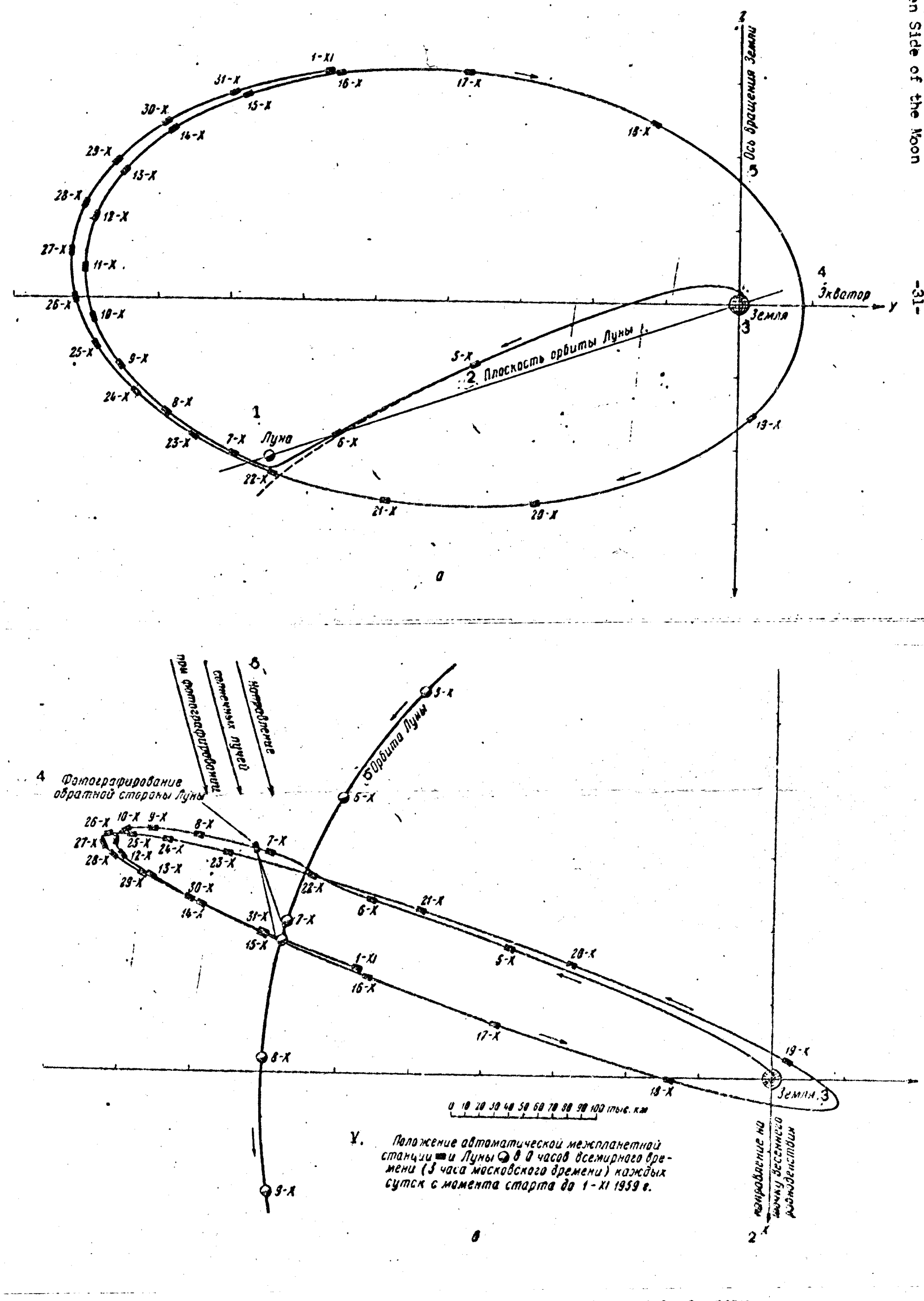

FIGURE 4. FLIGHT TRAJECTORY OF THE INTERPLANETARY STATION

a) View from the side of the point of spring equinox
1 - the moon 2 - orbit plane of the moon 3 - the earth 4 - equator
5 - rotation axis of the earth
b) Projected onto the plane of the earth equator

1. Position of the automatic interplanetary station and of the moon at 0 hours international time (3:00 Moscow time) on each day from the time of launching to November 1, 1959.
2. Direction to the point of spring equinox.
3. The earth.
4. Taking photographs of the far side of the moon.
5. Direction of solar rays during photographing.
6. Orbit of the moon.

Table on Page

Automatic Interplanetary Sta[illegible]
(Automaticheskaia Mezhpla[illegible]
[illegible]naia Stantsiia)

See p. 15.

	Date	Time (Moscow)	Distance from the Center of the Moon, km	Selenographic Projection ~~AMS~~ AIS Latitude	Longitude
Photographing Started	10-7-59	$6^h\ 30^m$	65,200	16.9^o	117.6^o
Photographing Ended	10-7-59	$7^h\ 10^m$	68,400	17.3^o	117.1^o

FIGURE 5. POSITION OF THE AUTOMATIC INTERPLANETARY STATION IN SPACE WHEN PHOTOGRAPHS OF THE FAR SIDE OF THE MOON WERE TAKEN (Arrows indicate the direction of solar rays)

FIGURE 6. A PHOTOGRAPH OF THE FAR SIDE OF THE MOON TAKEN FROM THE AUTOMATIC INTER-PLANETARY STATION.

FIGURE 7. A PHOTOGRAPH OF THE FAR SIDE OF THE MOON TAKEN FROM THE AUTOMATIC INTERPLANETARY STATION

Caption for:

FIGURE 8. LOCATION OF OBJECTS ON THE FAR SIDE OF THE MOON REVEALED BY PRELIMINARY PROCESSING OF PHOTOGRAPHS TAKEN FROM THE AUTOMATIC INTERPLANETARY STATION:

1. Moscow Sea, a large crater sea 300 km in diameter.
2. Bay of Astronauts in Moscow Sea.
3. Continuation of South Sea on the far side of the moon.
4. Tsiolkovskiy Crater, a crater with a central elevation.
5. Lomonosov Crater, a crater with a central elevation.
6. Joliot-Curie Crater.
7. Mountain Ridge Sovetskiy.
8. Dream Sea (~~[illegible]~~ Mechty).

Solid line intersecting the system is lunar equator; dotted line is the boundary between the visible and invisible sections of the moon. Objects definitely determined by the preliminary processing are circled with a solid line; objects the shapes of which need verification are circled with a dotted line; objects the classification of which is being verified are encircled by dots the obtained photographs of other areas are being processed further.

Roman numerals designate objects on the visible side of the moon:

I. Humboldt Sea.
II. The Sea of Crises.
III. The Edge Sea, which continues on the far side of the moon.
IV. The Sea of Waves.
V. Smyth Sea, which continues on the far side of the moon.
VI. The Sea of ~~Fertility.~~ (Foecunditatis)
VII. South Sea, which continues on the far side of the moon.